

**SAF for Land Surface Analysis
LSA-SAF (Land SAF)**

**Product Output Format Document
Version 1.8**

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SAF/LAND/IM/POF/1.8

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1 Introduction

1.1 Purpose

The strategy underneath the format specification applicable for the LSA-SAF system was to define a common data format that could be transversally used within the whole application. The idea is to define a data format that can be applied not only to the system end products, but also to all its internal files (internal products and pre-processed input data).

This document specifies the used formats within the LSA-SAF context and gives a detailed description of files contents. It is addressed to end users of the LSA-SAF user community.

Some of the information provided in this document was included previously in ADD [RD.2] Appendix J. After MTR-2 and resulting from a reorganisation on the provided information it was decided to keep a centralised document where all relevant information related to the LSA-SAF data formats could be found – this document. As a consequence a reference to this Output Products Document was inserted in the previously mentioned ADD appendix.

1.2 Scope

The requirements on the LSA-SAF system in terms of products content, products format and distribution are expressed in the Software Requirements Document (SRD) [RD.1]. These are the bases for establishing the data format applicable to the system.


In terms of data involved in the LSA-SAF products generation and distribution the following rationale applies:

- Raw data (not pre-processed) is ingested in the system, pre-processed by dedicated components and archived. Raw data can be in different formats since provide from different sources;
- After archived the pre-processed data is used by the system algorithms to generate the products. The generated products are the following:

Acronym	Product
AL	Surface Albedo
BRDF	Bi-directional Reflectance Distribution Function
AE	Aerosol
LST	Land Surface Temperature
EM	Surface Emissivity
TSP	Thermal Surface Parameter
DSSF	Downwelling Surface Shortwave Fluxes
DSLFL	Downwelling Surface Longwave Fluxes
SM	Soil Moisture
SC	Snow Cover
ET	Evapotranspiration
LAI	Leaf Area Index
FVC	Fractional Vegetation Cover

Table 1: LSA-SAF products

- The generated products are then distributed over the user community through different medias in HDF5 format.

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As it can be seen a myriad of different formats exist in LSA-SAF system entrance. To optimise the system and to assure data consistency, an internal data format is essential. The idea is to impose that inside the LSA-SAF all data, both input and output, shall comply with the established internal format. Only the components dealing with data ingestion deal with different data formats.

The HDF5 data format was selected as the LSA-SAF internal and output data format because:

- It is compliant with all system data format drivers;
- It is a mature format, adequate to be used with scientific data;
- IM experience in working with HDF5 data will ease the associated development activities.


1.3 Definitions, acronyms and abbreviations

1.3.1 Acronyms

DD	Day
Euro	Europe
HDF	Hierarchical Data Format
hh	Hour
LSB	Lower Significant Bit
IOP	Initial Operations Phase
mm	Minute
MM	Month
MSB	Most Significant Bit
NAfr	Northern Africa
RD	Reference Document
RMDCN	Regional Meteorological Data Communication Network
ss	Second
SAfr	Southern Africa
SAme	Southern America
U-MARF	Unified Meteorological Archive and Retrieval Facility
WMO	World Meteorological Organization
YYYY	Year

1.3.2 Definition of Terms

Attribute	A small dataset that can be used to describe a specific characteristic of the data stored in the same file.
Dataset	A multi-dimensional array of data elements. A dataset can support several attributes.
HDF5 file	A container for storing datasets and attributes in Hierarchical Data Format.

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1.4 References


1.4.1 Reference documents

- [RD.1] LSA-SAF (Land SAF) System/Software Requirements Document (SRD)
Ref.: SAF/LAND/IM/SRD3.8
- [RD.2] LSA-SAF (Land SAF) Architectural Design Document (ADD)
Ref.: SAF/LAND/IM/ADD2.6
- [RD.3] HDF5 File Format Specification
Ref.: <http://hdf.ncsa.uiuc.edu/HDF5/doc/H5.format.html>
- [RD.4] UMARF SAF Metadata Definition
Ref.: EUM/UMA/TEN/030/I1R5

1.5 Overview of the document

The document has the following structure.

- Chapter 2** Presents the system drivers for establishing the LSA-SAF product format definition
- Chapter 3** Describes the data formats existent at LSA-SAF system entrance
- Chapter 4** Describes in detail the LSA-SAF internal data format
- Chapter 5** Describes the data formats applicable to the LSA-SAF products distribution
- Appendix A** Contains the traceability matrix between the UMARF parameters and the LSA-SAF metadata

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2 Product Format Drivers


The LSA-SAF internal data format was established taken into consideration the following drivers:

SRD Requirement	Requirement text
SR-DS-IT-0080	The LSA-SAF products to be disseminated through GTS shall be encoded into a standard WMO code (e.g. GRIB for global coverage, BUFR projection on an irregular grid).
SR-DS-PO-0100	The ordered products shall be delivered to users using, as much as possible, a file format independent of hardware, software environment, tools, etc. Standard file formats (e.g. EPS Native, HDF, BUFR) will be used whenever they meet all the requirements needed for the product file format.

Table 2: LSA-SAF product format definition design drivers

As it can be seen the first system requirement refers to products dissemination using a dedicated media – GTS – and therefore has nothing to do with the LSA-SAF internal data format. Using a different format, like HDF5, to describe data inside the LSA-SAF system will not disrespect such driver. The only consequence is that after generating the products some additional post-processing activities are required in order to perform the reformatting.

The second requirement is completely in-line with the HDF5 selection, which validates such decision in terms of system requirements compliance.

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3 Raw Input Data Formats

After assessing the LSA-SAF algorithms needs it can be observed that input data ingested in the LSA-SAF system can be logically grouped as follows: time variant data and time invariant data. The first group comprise all data periodically ingested in the system like the satellite images, the SAF NWC products and the ECMWF forecasts. The time invariant group encompasses all static (or quasi-static) data like climatological data, land/water masks, land cover maps and digital elevation model, for example.

The following table summarises the LSA-SAF system inputs in terms of external input data providers and the data format applicable to each:


Group	Data provider	Data	Format
Time variant data	MGS Ground Station	MSG Images	HRIT
	NWC SAF	NWC SAF products	HDF5
	ECMWF	ECMWF forecasts	GRIB
Time invariant data	Others ¹	Auxiliary quasi-static ² data	HDF5, BINARY or ASCII

Table 3: Raw input data formats

The LSA-SAF components responsible for taking care of the system input data ingestion will therefore have the capability of dealing with these different types of data. For data within the time variant group pre-processing routines will prepare the input data and assure the conversion to HDF5, when applicable (note that the NWC SAF outputs are already made available to the LSA-SAF in the desired format). For all other remaining input data it will be the LSA-SAF operator responsibility to insert them into the system in HDF5 format, following a manual procedure, in order to make them available to the system processing chain. For these cases any required format conversions shall occur before the system data insertion and is out of LSA-SAF system scope.

¹ This will encompass all other input data provided by external data sources different from the ECMWF, MSG images and NWC SAF.

² This quasi-static term means that the input data grouped under this category is not expected to vary significantly over time. This is due to the fact that the system operator inserts this input data in the LSA-SAF system manually and therefore it would be impractical to have highly time variant data considered here.

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4 LSA-SAF Internal Format Definition

The internal data format for the LSA-SAF system is HDF5 [RD.3]. End products, internal products and input data files (already pre-processed) are in the same format and have the same structure.

4.1.1 Structure

The HDF5 files in LSA-SAF system have the following structure:

- A common set of attributes for all kind of data, containing general information about the data (including metadata compliant with U-MARF requirements [RD.4]);
- A dataset for the parameter values;
- Additional datasets for metadata (e.g., quality flags).

In this context a dataset is composed by a set of common attributes and a space for the data. The datasets might have different dimensions and different number of bytes per pixel (1 or 2 bytes).

Each file contains a single product or parameter and the respective metadata. Figure 1 shows an example of LSA-SAF files structure for the albedo product.

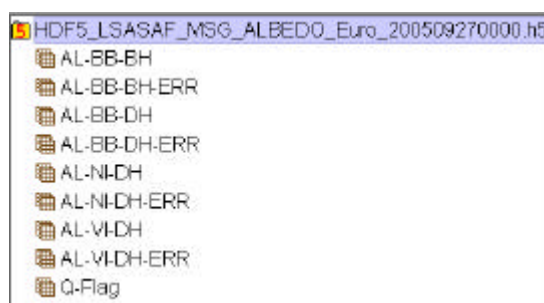


Figure 1: Example of LSA-SAF files structure

The set of general attributes to be part of all LSA-SAF files, and their possible values, are described in Table 4. The common attributes for the datasets are described in Table 5.

In this table the following naming convention applies:

{ACE}	=	'ACE1', 'ACE2', 'ACE3', 'ACE4'
{COSMIC}	=	'COSMIC1', 'COSMIC2', 'COSMIC3', 'COSMIC4'
{DMSP}	=	'F13', 'F14', 'F15', 'F16',
{GOES}	=	'GOES-10', 'GOES-11', 'GOES-12'
{METOP}	=	'M01', 'M02', 'M03'
{MSG}	=	'MSG1', 'MSG2', 'MSG3'
{NOAA}	=	'N15', 'N16', 'N17', 'N18', 'N19', 'Nx'

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Attribute	UMARF Short Name	Description	Data Type	Allowed Values
SAF	-	SAF package	String<3>	LSA
CENTRE	PPRC	Institution (generating/disseminating data)	String<5>	One of: ECMWF, EUM, IM-PT, UV, MF, RMI, IMK, ICAT, FMI
ARCHIVE_FACILITY	AARF	Centre where the data is archived	String<5>	IM-PT
PRODUCT	APNA	Defines the name of the product	String<79>	One of: LST, AL, SC, ... (see Table 1)
PARENT_PRODUCT_NAME	APPN	Array of up to 4 product names, upon which the product is based	Array(4) of string<79>	Up to 4 of: LST, AL, SC, ... (see Table 1)
SPECTRAL_CHANNEL_ID	-	Channel Identification for MSG images and derived products	Int	Depends on the channels used by the product or on the images present in file. 1 bit per channel, where LSB is HRV and MSB is IR13.4; values are 0 if not used, 1 if used. 0 – No channel 2047 – All Channels
PRODUCT_ALGORITHM_VERSION	AVPA GNFV AVBA	Version of the Algorithm that produce the product (AVPA). Concatenated string of Major/Minor Processor Version separated by a dot (GNFV).	String<4>	
CLOUD_COVERAGE	QCCV	Indicator of the cloud coverage in the product	String<20>	Free text. e.g. NWC-CMa, ...
OVERALL_QUALITY_FLAG	QQQV	Overall quality flag for the product	String<3>	OK, NOK
ASSOCIATED_QUALITY_INFORMATION	QQAI	Several miscellaneous quality indicator for the product	String<511>	Free text.
REGION_NAME	AAAR	Processed Region Name	String<4>	One of: Euro, NAfr, SAfr, SAm.
COMPRESSION	-	Compression Flag	Int	0 – Uncompressed 1 – Compressed
FIELD_TYPE	-	Data filed type	String<255>	One of: Image, Observation, Forecast, Static, Quasi-Static, or Product.
FORECAST_STEP	-	Forecast Step in Hours	Int	0, 3, ..., 21
NC	-	Maximum number of columns for all datasets in file	Int	≤2211 (Possible to update if necessary)

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Attribute	UMARF Short Name	Description	Data Type	Allowed Values
NL	-	Maximum number of lines for all datasets in file	Int	≤1511 (Possible to update if necessary)
NB_PARAMETERS	-	Number of datasets in file	Int	≤10 (Possible to update if necessary)
NOMINAL_PRODUCT_TIME	PPST	Nominal Time of the Product. Time in UTC at which product is generated.	String<12>	YYYYMMDDhhmm
SATELLITE	ASTI	Platform identifier (mission and spacecraft the product originated from).	Array[10] of String<9>	{ACE},{COSMIC},{DMSP},{GOES},{MET OP},{MSG},{NOAA}
INSTRUMENT_ID	AID	Instrument which acquired the product or data used by the product	Array [10] of String<6>	'ATOV', 'ASCA', 'SEVI', 'AVHR', 'VIRGO', 'SOVIM', 'SOVA', 'ACRIM3', 'TIM', 'GERB', 'CERES', 'GOME', 'HIRS', 'GRAS', 'QSCAT', 'SCAT', 'Imager', 'SSM/I', 'AMI'
INSTRUMENT_MODE	SMOD	Scanning mode of the instrument at the time of the acquisition.	String<511>	'NORTH_POLAR_VIEW', 'SOUTH_POLAR_VIEW', 'NARROW_VIEW', 'NORMAL_VIEW', 'STATIC_VIEW', 'OCCULTATION'
IMAGE_ACQUISITION_TIME	SNIT	Time in UTC at which the image or product is defined to be valid (or time slot).	String<12>	Start Acquisition Time for SEVIRI 1.5 Images and for products based on those images Equal to SENSING_START_TIME for EPS based products and images Format: YYYYMMDDhhmm
ORBIT_TYPE	GORT	Orbit type of the spacecraft, indicating the coverage of the product:	String<3>	"GEO" - geo-stationary "LEO" - low-earth (polar), "MMP" - multi-mission
PROJECTION_NAME	LMAP	Projection name and longitude of sub-satellite point (after projection)	String<15>	Geos<sub_lon> (as from SEVIRI 1.5 Images)
NOMINAL_LONG	-	Actual Satellite Nominal Longitude	Real	As from SEVIRI 1.5 Images
NOMINAL_LAT	-	Actual Satellite Nominal Latitude	Real	As from SEVIRI 1.5 Images
CFAC	-	Column Scaling Factor for Geo-referencing proposes	Int	As from SEVIRI 1.5 Images

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Attribute	UMARF Short Name	Description	Data Type	Allowed Values
LFAC	-	Line Scaling Factor for Geo-referencing proposes	Int	As from SEVIRI 1.5 Images
COFF	-	Column Offset for Geo-referencing proposes (Only for MSG data)	Int	Depends on Region: e.g., Euro:308; NAfr:618; SAfr:-282; SAme:1818.
LOFF	-	Line Offset for Geo-referencing proposes (Only for MSG data)	Int	Depends on Region: e.g., Euro:1808; NAfr:1158; SAfr:8; SAme:398.
START_ORBIT_NUMBER	LONS	First of two orbit numbers in the EPS product, valid at the starting of the sensing, i.e, at the beginning of a dump	Int	
END_ORBIT_NUMBER	LONE	Final of the orbit numbers in the EPS product, valid at the ascending node crossing, i.e. towards the end of a dump	Int	
SUB_SATELLITE_POINT_START_LAT	LLAS	Latitude of sub-satellite at start of acquisition	Real	-90 to 90
SUB_SATELLITE_POINT_START_LON	LLOS	Longitude of sub-satellite at start of acquisition	Real	-180 to 180
SUB_SATELLITE_POINT_END_LAT	LLAE	Latitude of sub-satellite at end of acquisition	Real	-90 to 90
SUB_SATELLITE_POINT_END_LON	LLOE	Longitude of sub-satellite at end of acquisition	Real	-180 to 180
SENSING_START_TIME	SSBT	UTC date and time at acquisition start of the product. Used as internal search parameter for LEO queries to find products matching with the time period defined by the end-user, and to find products matching with the RoI defined by the end-user.	String<12>	YYYYMMDDhhmm

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Attribute	UMARF Short Name	Description	Data Type	Allowed Values
SENSING_END_TIME	SSST	UTC date and time at acquisition start of the product. Used as internal search parameter for LEO queries to find products matching with the time period defined by the end-user, and to find products matching with the RoI defined by the end-user.	String<12>	YYYYMMDDhhmm
PIXEL_SIZE	-	For image products, size of pixel at nadir. For meteorological products resolution/accuracy	String<10>	Free text. e.g. "3.1Km" for MSG images
GRANULE_TYPE	GGTP	Type description of the item	String<2>	For MSG products: "DP" - Data Product, "SP" - Spacecraft Telemetry
PROCESSING_LEVEL	GPLV	Processing Level Applied for generation of the product	String<2>	"01" for MSG images "02" for Layer 1 products (LST & AL) "03" for Layer 2 products (DSSF & DSLF) "04" for Layer 3 products (SC, ET SM, FVC & LAI) "- " for Other data
PRODUCT_TYPE	APNM	Abbreviated name of the product type for UMARF (Concatenation of SAF name with Product name)	String<8>	One of: LSALST, LSAAL, LSASC, LSADSSF, ... (see Table 1)
PRODUCT_ACTUAL_SIZE	APAS	Actual size of the product in bytes (needed for information to end-users).	Integer > 0, encoded as String<11>	Depends on number of bytes per pixel and on region
PROCESSING_MODE	GPMD	Processing mode applied for generation of the product.	String<1>	'N' := Nominal 'B' := Backlog 'R' := Reprocessing 'V' := Validation
DISPOSITION_FLAG	GDMD	Disposition mode applied for generation of the product. .	String<1>	One of T' := Testing 'O' := Operational 'C' := Commissioning
TIME_RANGE	AATR	Temporal Resolution	String<20>	'annual', 'seasonal', 'monthly', 'weekly', 'daily', 'hourly', 'instantaneous', 'twice a day', '10-day', '15-min', '30-min',...
STATISTIC_TYPE	AAST	Statistic Type	String<20>	'mean', 'sum', 'diurnal cycle', 'frequency',..., or N/A

Table 4: General Attributes of LSA-SAF files. Mandatory attributes are in bold.

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Attribute	Description	Data Type	Value
CLASS	Dataset type	String	One of: Image, Data, Palette.
PRODUCT	Defines the name of the product	String	Depends on dataset One of: LST, AL, SC..., Quality_Flags,...
PRODUCT_ID	Product identification accordingly with WMO tables	Int	Depends on dataset
N_COLS	Number of columns	Int	Depends on dataset
N_LINES	Number of lines	Int	Depends on dataset
NB_BYTES	Number of bytes per pixel	Int	Depends on dataset
SCALING_FACTOR	Scaling factor for the parameter	Real	Depends on dataset.
OFFSET	Offset of the scaling factor	Real	Depends on dataset.
MISSING_VALUE	Missing value	Int	Depends on dataset
UNITS	Parameter Unities	Int	One of: SI, Adim., ...
CAL_SLOPE	Calibration Constant	Real	As from SEVIRI 1.5 Images. (Physical_Unit = CAL_OFFSET + CAL_SLOPE x Pixel_Count). Units are $\text{mW m}^{-2} \text{sr}^{-1} (\text{cm}^{-1})^{-1}$
CAL_OFFSET	Calibration Constant	Real	

Table 5: Dataset Attributes. Mandatory attributes in bold.

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4.1.2 Data Types

The data types to be used in HDF5 files are given in the table below.

Data Type	HDF5 Predefined Data Type
Int	H5T_NATIVE_INTEGER
Real	H5T_IEEE_F64BE or H5T_IEEE_F64LE (Depends on the machine where the file is created)
String	H5T_NATIVE_CHARACTER

Table 6: Data types for the HDF5 LSA-SAF files

4.1.3 File names


The file name of the LSA-SAF internal, input and output files is a string of up to 255 characters made of 6 fields separated by underscores with shape:

FORMAT_FREE_SOURCE_VARIABLE_AREA_DATE

Where:

- FORMAT is HDF5;
- FREE is a free field;
- SOURCE is the data provider (see Table 3);
- VARIABLE is the parameter or product stored in the file;
- AREA is one of the processed regions: Euro, NAfr, SAfr or SAm;
- DATE is the time slot in YYYYMMDDhhmm, or the run time in the case of numerical weather prediction data.

Note: If data are disseminated via EUMETCast the FORMAT field is prefixed by “S-LSA-” string.

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5 Formats for Products Dissemination

5.1 Dissemination Media

Products are disseminated in near real time (NRT) via EUMETCast. Off-line distribution to users is also possible via ftp (<http://landsaf.meteo.pt>) or CD-ROM (requests should be sent to helpdesk.landsaf@meteo.pt).

Media	Acronym	Description
EUMETCAST	AL	Surface Albedo
	LST	Land Surface Temperature
	SC	Snow Cover
	DSSF	Downwelling Surface Shortwave Fluxes
	DSLFL	Downwelling Surface Longwave Fluxes
Offline distribution	All	All products

Table 7: Dissemination media


5.2 Disseminated Products Format

5.2.1 EUMETCast

This link is a dedicated line to EUMETSAT for subsequent dissemination via the EUMETCast system, with products formats defined in conjunction with EUMETSAT. Currently for meteorological products, EUMETCast is distributing using BUFR and GRIB2, and HDF5. The latter is the format used for LSA SAF products.

5.2.2 Offline Distribution


Products may also be disseminated off-line through the LSA SAF website (<http://landsaf.meteo.pt>) and through requests to the LSA SAF helpdesk (helpdesk.landsaf@meteo.pt). In any case, products shall be distributed in HDF5 format.

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Appendix A. Traceability matrix - UMARF and LSA-SAF metadata

The following table lists the relationship between the LSA-SAF attributes and the UMARF metadata. The bold attributes are the mandatory ones.

UMARF short name	LSA-SAF attribute name	Notes
ASTI	SATELLITE_ID	
GORT	ORBIT_TYPE	
LONS	START_ORBIT_NUMBER	
LONE	END_ORBIT_NUMBER	
LLAS	SUB_SATELLITE_POINT_START_LAT	
LLOS	SUB_SATELLITE_POINT_START_LON	
LLAE	SUB_SATELLITE_POINT_END_LAT	
LLOE	SUB_SATELLITE_POINT_END_LON	
LSVT		Ascending Node Crossing Date and Time; N/A for LSA-SAF
OCSA		Occultation Satellite ID; N/A for LSA-SAF
OCLA		Occultation Latitude; N/A for LSA-SAF
OCLO		Occultation Longitude; N/A for LSA-SAF
OCTM		Occultation Date and Time; N/A for LSA-SAF
AIID	INSTRUMENT_ID	
SMOD	INSTRUMENT_MODE	
SSBT	SENSING_START_TIME	
SSST	SENSING_END_TIME	
ABID		Spectral Band Ids; N/A for LSA-SAF
GNSP		Number of Spectral Bands; N/A for LSA-SAF
RRCC		Receiving Centre; N/A for LSA-SAF
RRBT		Reception Start Date and Time; N/A for LSA-SAF
RRST		<i>Ibid.</i> End Date and Time; N/A for LSA-SAF
PPRC	CENTRE	
PPDT		Processing Start Date and Time; N/A for LSA-SAF
PPST	NOMINAL_PRODUCT_TIME	
GPLV	PROCESSING_LEVEL	
AVBA	PRODUCT_ALGORITHM_VERSION	
AVPA	PRODUCT_ALGORITHM_VERSION	
LMAP	PROJECTION_NAME	
SNIT	IMAGE_ACQUISITION_TIME	
GDMD	DISPOSITION_FLAG	

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UMARF short name	LSA-SAF attribute name	Notes
GPMD	PROCESSING_MODE	
APNM	PRODUCT_TYPE	
APNA	PRODUCT	
APPN	PARENT_PRODUCT_NAME	
AAST	STATISTIC_TYPE	
AATR	TIME_RANGE	
AAAR	REGION_NAME	
APAS	PRODUCT_ACTUAL_SIZE	
GNPO		Native Pixel Order; N/A for LSA-SAF
GNFV	PRODUCT_ALGORITHM_VERSION	
QCCV	CLOUD_COVERAGE	
QQOV	OVERALL_QUALITY_FLAG	
QQAI	ASSOCIATED_QUALITY_INFORMATION	
QDRC		Degraded Record Count; N/A for LSA-SAF
QDRP		Degraded Record Percentage; N/A for LSA-SAF
QDLC		Missing Data Count; N/A for LSA-SAF
QDLP		Missing Data Percentage; N/A for LSA-SAF
AARF	ARCHIVE_FACILITY	
UUDT		Ingestion Date and Time; N/A for LSA-SAF
GGTP	GRANULE_TYPE	

Table 8: UMARF to LSA-SAF attributes traceability matrix

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